

Vehicle Safety Measures



**FORMULA
SAE
JAPAN
2022**

**クルマ+ものづくりに
熱中する学生たち**



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○ Prevention of fire

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(1) Fuel line

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2. About Eng damage

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○ Driver protection

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○ Other precautions

4. Shakedown

Prevention: 1-(1) Fuel line (clamp/joint)



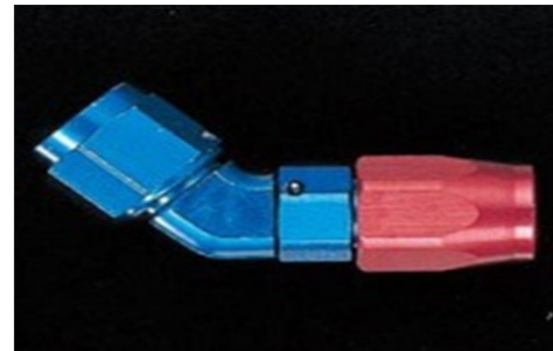
In order to prevent a fire accident, first of all, do not leak fuel.
The leaky "fitting" part is recommended as follows

IC.5.7.4 conformance
Fuel hose clamp



No loosening required for clamps

IC.5.7.4 (IC.6.2.3)
compliant joint



IC.5.7.5 Non-conformance (not available)
Fuel hose clamp



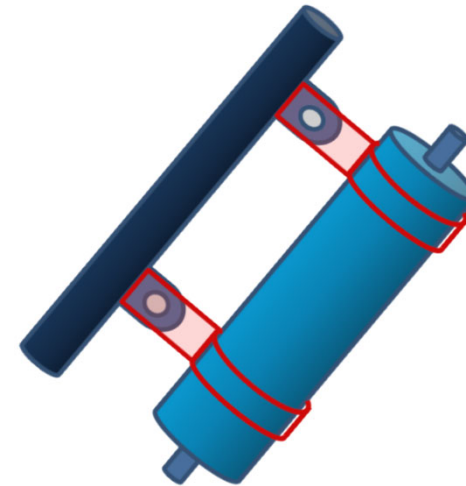
Can be used where there is
no pressure such as return

* There are fire reference cases

Prevention: 1-(1) Fuel line (fuel pump)



Loose vibration of the fuel pump fixation may cause fuel leakage from the fitting
Clamps recommend secure fixation



Example of clamp of fuel pump, etc.

Prevention: 1-(1) Fuel line (leak check)



washing



osmosis



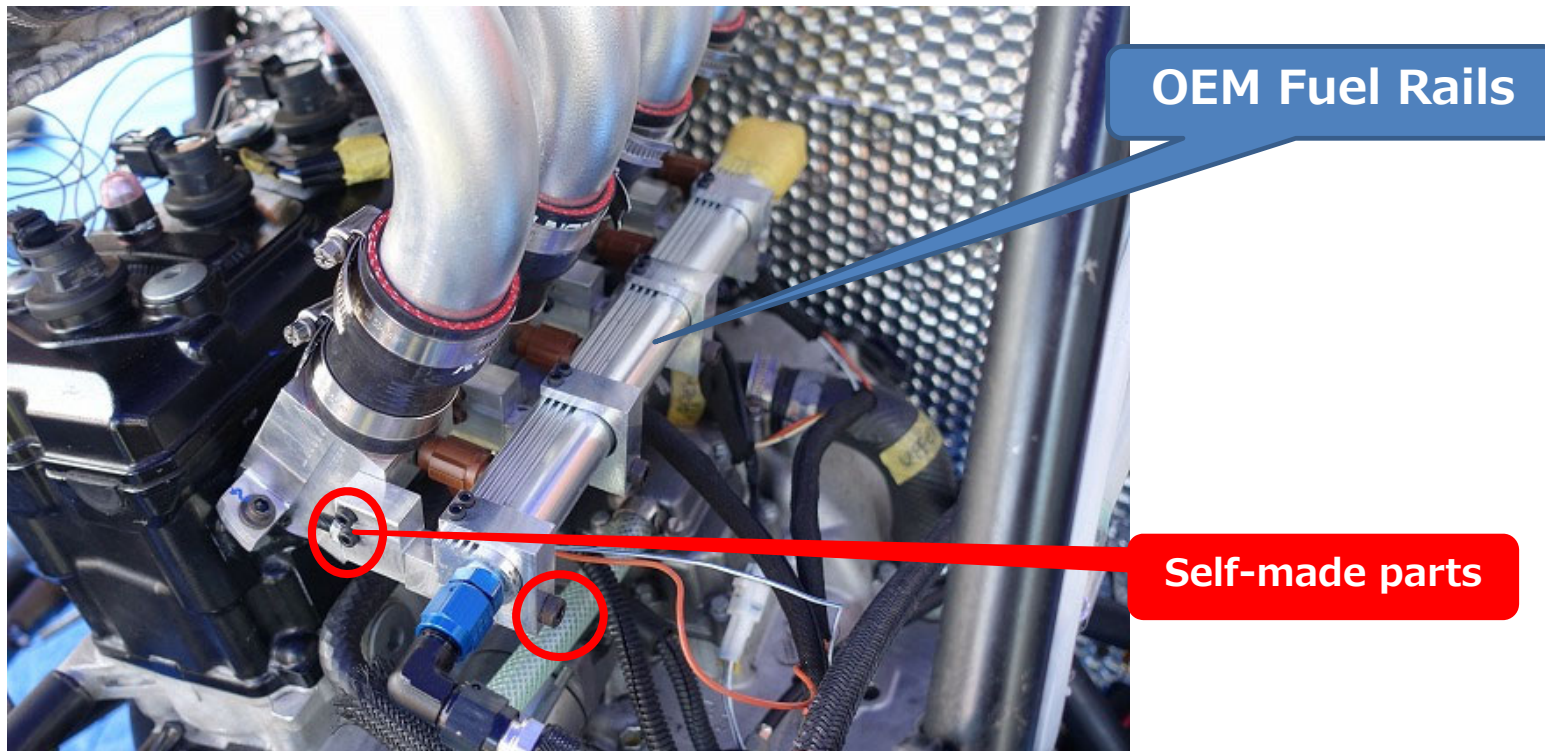
developing

When a developer for staining penetrant testing is used, even a slight bleeding can be detected at an early stage. Originally, it mainly detects cracks in metals. It is used in the order of washing (yellow>), penetration (red), washing (yellow> > development (light blue). The developer sucks out the penetrant that has soaked into the crack and checks for scratches. Only this developer can be used to detect oozing gasoline, oil, etc. By spraying the developer in advance, even a slight leak can be detected.

Prevention: 1-(2) Fuel rail

Even if the fuel rail is OEM, if the fastener is a self-made part, the critical fastener requirement (T. 8.2) is applied as a "self-made" system.

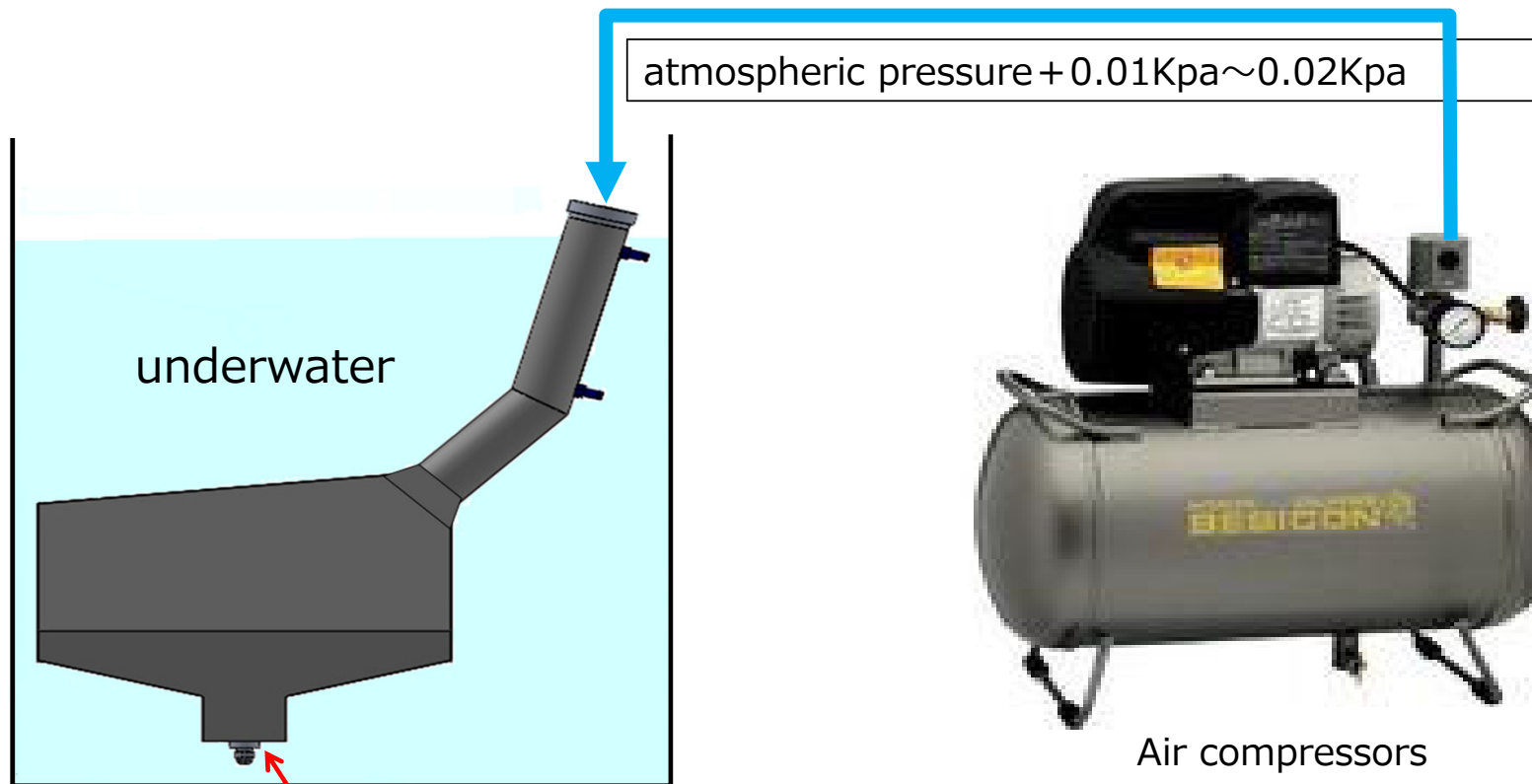
※ Photo red frame



Prevention: 1-(3) Fuel tank (airtightness confirmation)

Check the "tightness" in an appropriate way to prevent fuel leakage.

If you are not confident in the production, you can ask an outside company to produce it.



Reuse of drain washers



is strictly prohibited (use new each time)

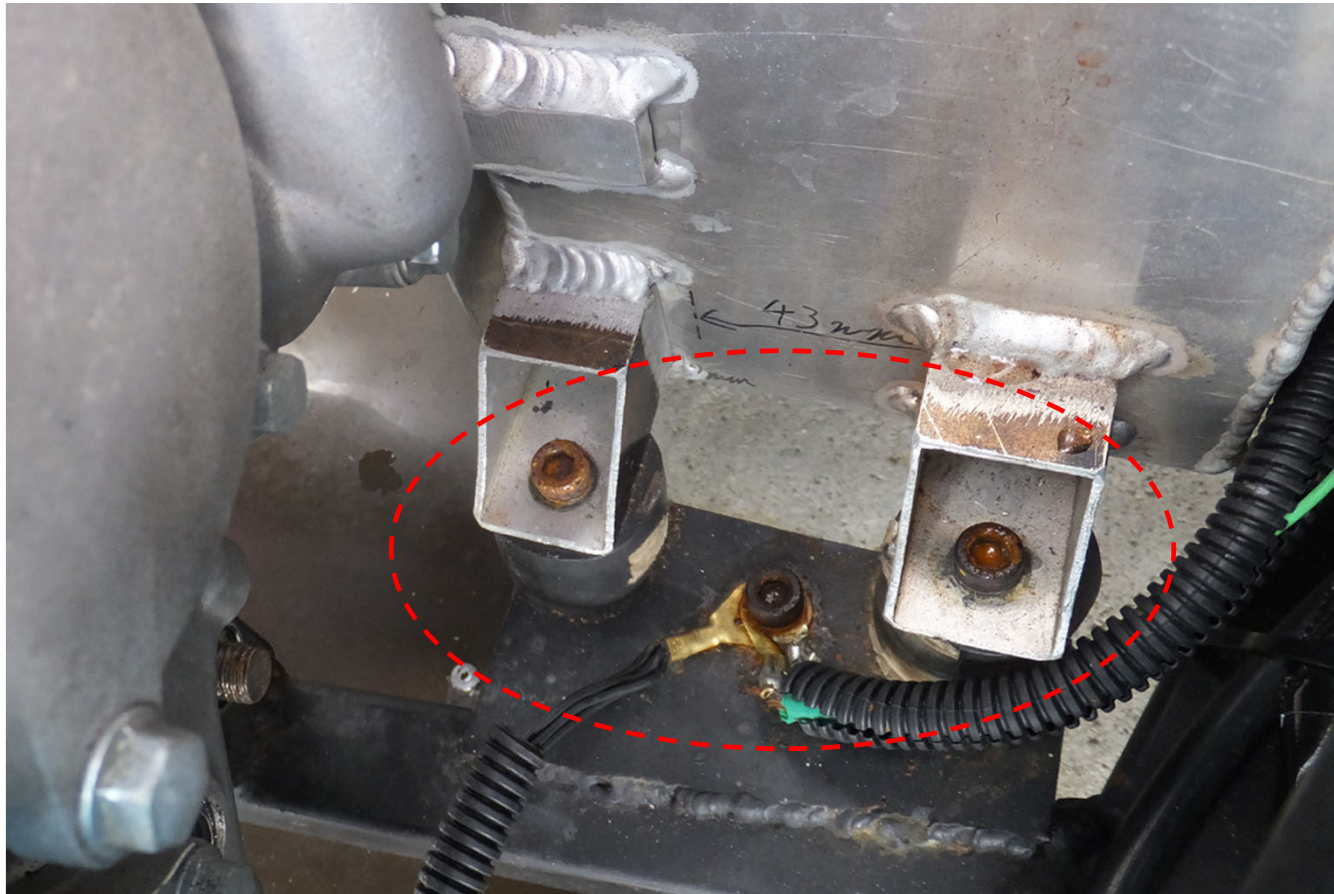
Prevention: 1-(3) Fuel tank (fixed with frame)



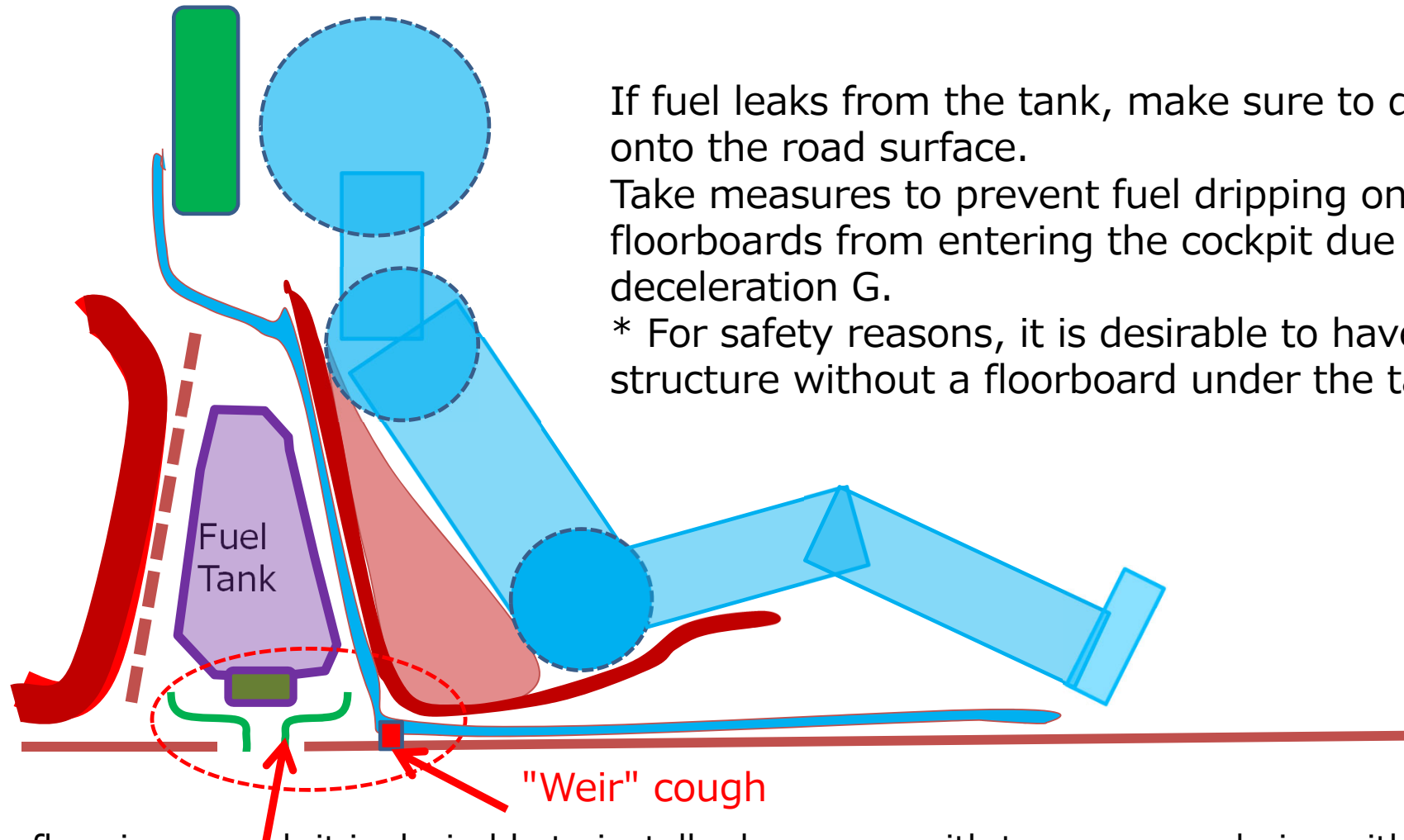
Allow room (such as rubber bushings) for installation so that the tank does not receive the load (torsion) of the chassis (X-Y axis).

* Take measures to reduce the axial torque of the mounting bolts without fail.

IC.5.3.1 If the bracket is vulnerable, it can crack



Prevention: 1-(3) Fuel tank (berry pan)



If fuel leaks from the tank, make sure to drip it onto the road surface.
Take measures to prevent fuel dripping onto the floorboards from entering the cockpit due to deceleration G.
* For safety reasons, it is desirable to have a structure without a floorboard under the tank.

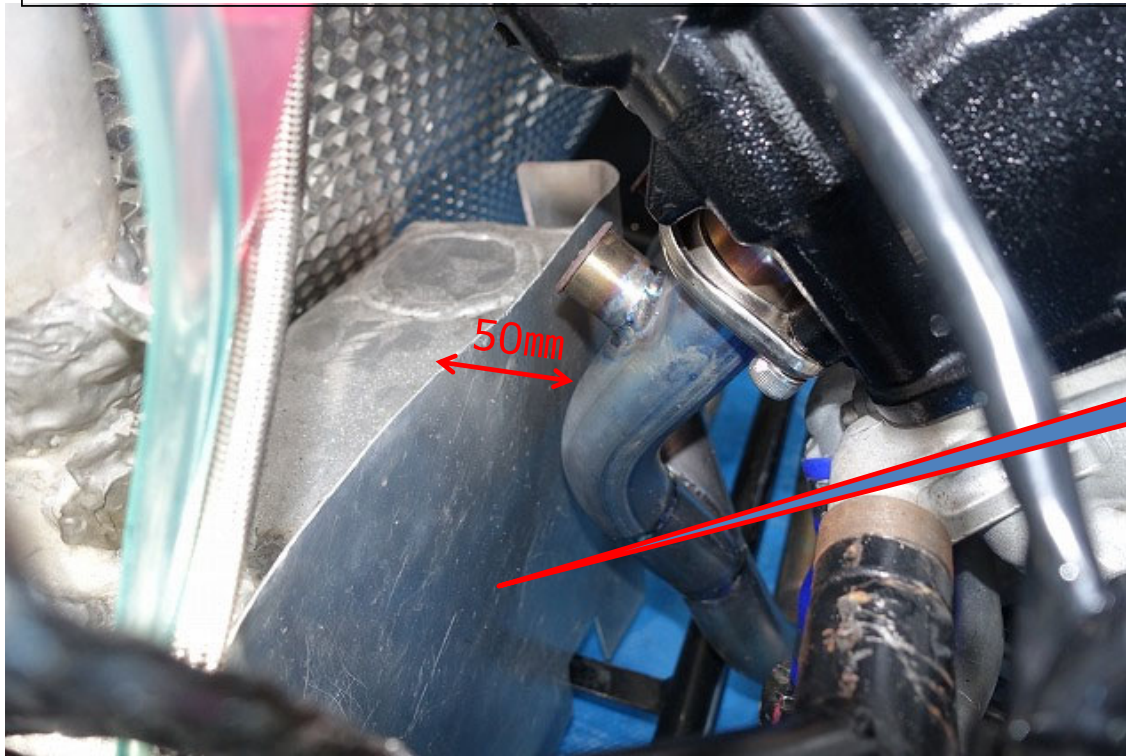
If the underfloor is covered, it is desirable to install a berry pan with two or more drains with two or more D25 mm holes. If there are only holes in the floorboard, a "weir" is used to prevent inflow into the cockpit.

Prevent: 1-(3) Fuel tank (distance to exhaust pipe)



- Ensure a clearance of at least 50mm between the fuel tank and exhaust pipe.
⇒ 2023 Defined in Local Rules

However, if 50 mm cannot be secured, add a heat shield with fire resistance equivalent to that of a firewall so that the fuel temperature during driving does not exceed the 50% distillation temperature of JIS standard K2202-2012, and submit evidence to prove this.

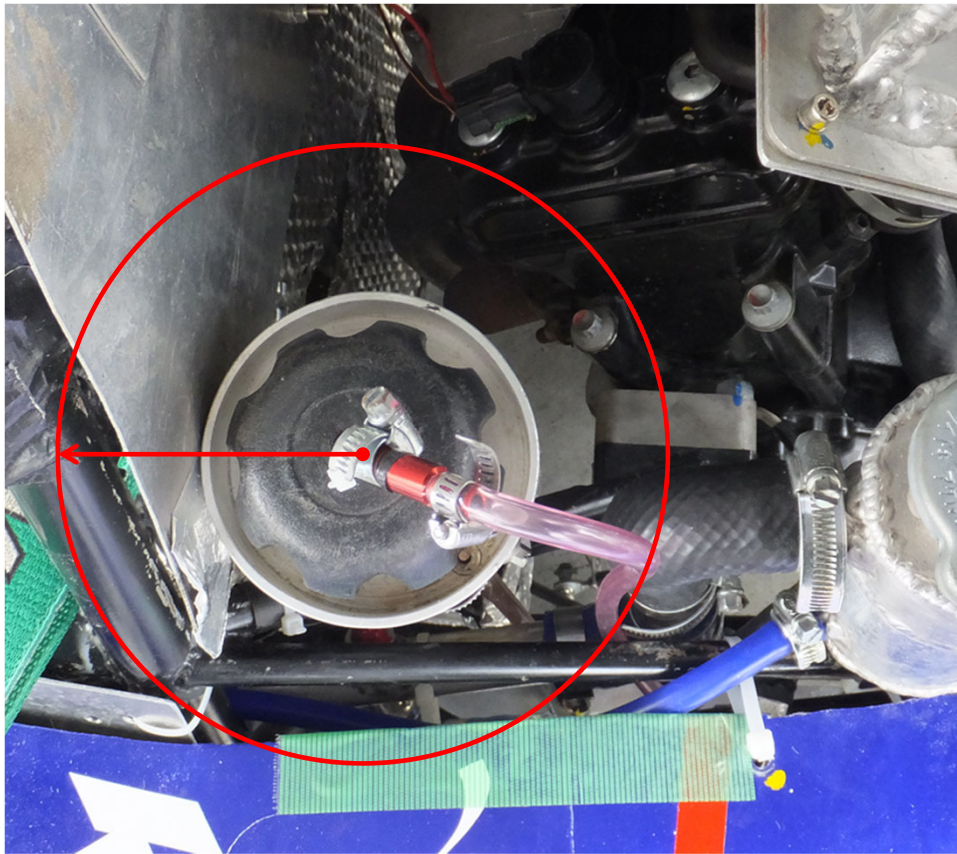


Heat shield

Prevention: 1-(3) Fuel tank (refueling port position)

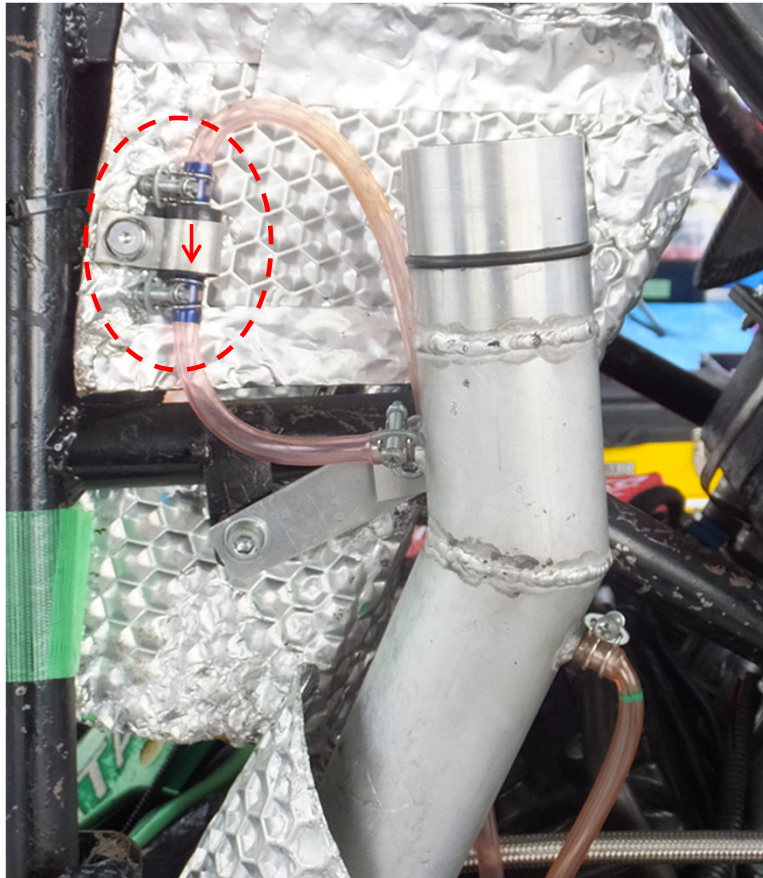
There are no ignition sources around the filling port to prevent ignition of spilled fuel when refueling. IC.5.2.1

* Generally within the range of the red circle



Prevention: 1-(3) Fuel tank (ventilation holes/tubes)

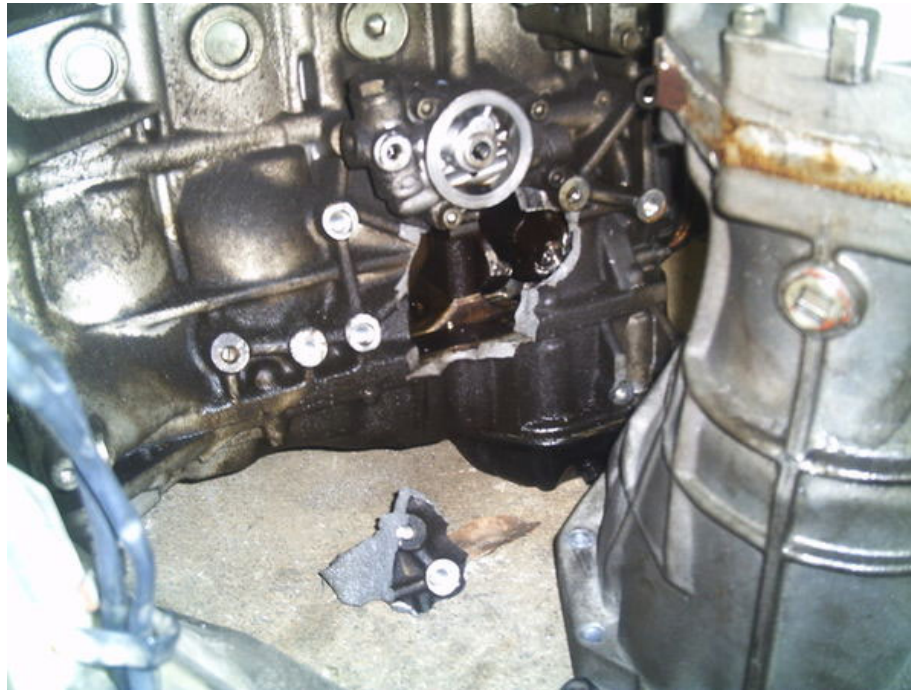
- How to use the vent (check valve)-
- Securely fixed vertically
- Pay attention to the orientation.
- Hang the tube to the bottom of the frame.



- (Site) Tube-
- Prohibition of the use of oil-resistant tubing
(Gasoline resistance proof)



Prevention: 2 Engine damage



The majority of fires at the Games were actually ignitions caused by large amounts of oil splatters caused by engine damage.

To break the block with the connecting rod sticking out the leg

(1) Burn-in from poor lubrication

(2) There are two main factors such as connecting rod coming off due to poor maintenance.

Prevention: 2-(1) Poor lubrication



Oil pressure alarm lamp



Oil pressure sensor

• As a countermeasure to poor lubrication, a means to confirm the decrease in oil pressure is provided.

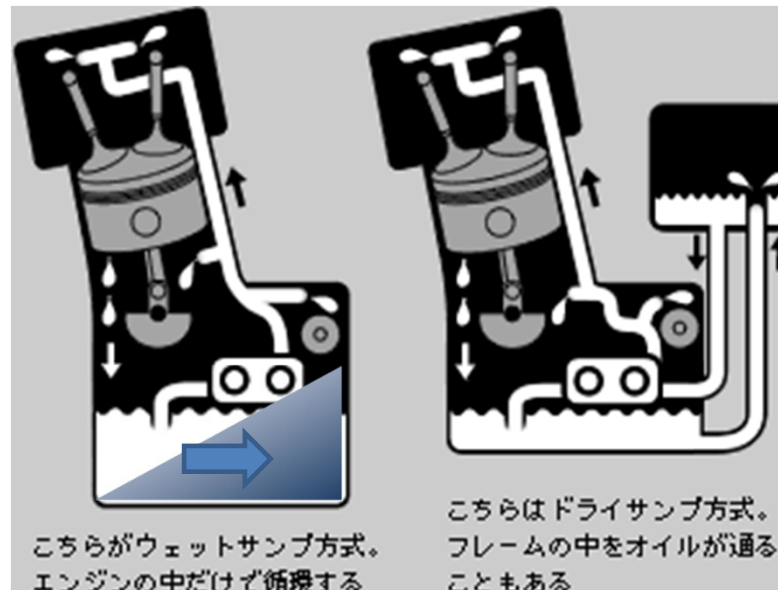
• Before driving without relying on the oil pressure warning light, check not only the amount of oil but also the "condition".
In past competitions, engine oil in an "emulsified" state, which seems to be contaminated with water, was found sometimes.

Prevention: 2-(1) Poor lubrication

Care for transverse G \Rightarrow Example: Dry sumpification

Wet sump method

Dry sump method



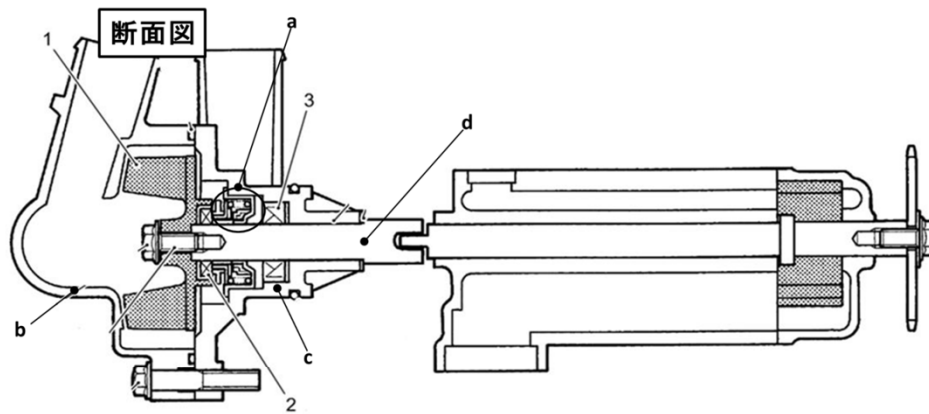
YAMAHA HP より

- When adopting a dry sump as a countermeasure against lateral G-forces, be aware of the following.
 - (1): Add a sufficient amount of engine oil. (At least 2~3 times the specified amount)
 - (2): Measures against air intake \Rightarrow foaming overflow \Rightarrow dripping on the road surface
 - (3): Oil temperature control (installation of oil cooler)
 - etc

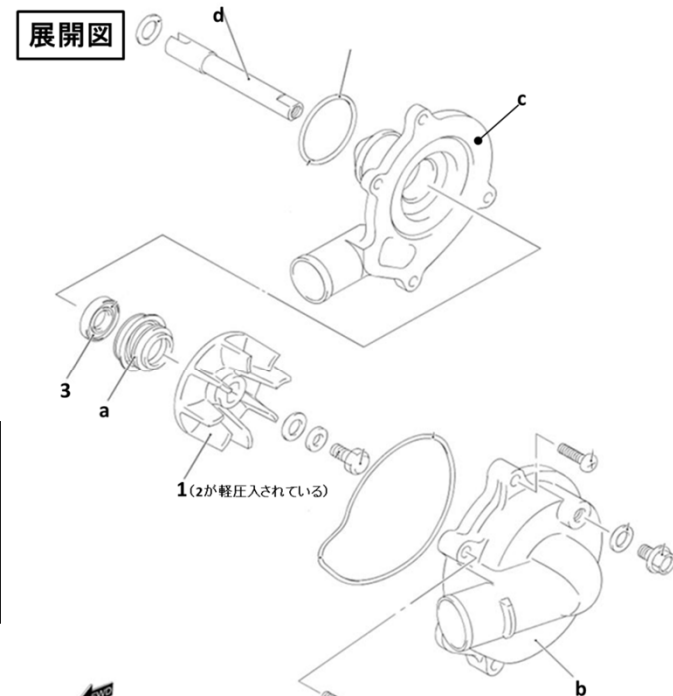
Prevention: 2-(1) Poor lubrication (water contamination in oil)

There were many cases where oil that had been mixed with water and transformed into an "emulsified" state was ejected.

(1) Water leakage from Water/Pump bearing



The engine is started ⇒ foreign matter in the water is generated ⇒
Seal foreign matter bite ⇒ seal wear ⇒ water leakage
* Stickers should also be replaced regularly.



(2) Water leakage due to overheating

Overheating ⇒ thermal distortion ⇒ water leakage

- 1. W/P impeller
- 2. Mechanical seal (floating sheet)
- a. Mechanical seal (sealing ring + spring + housing)
- 3. Oil seal
- b. W/P cover
- c. W/P body
- d. W/P shaft

Prevention: 2-(2) Poor maintenance

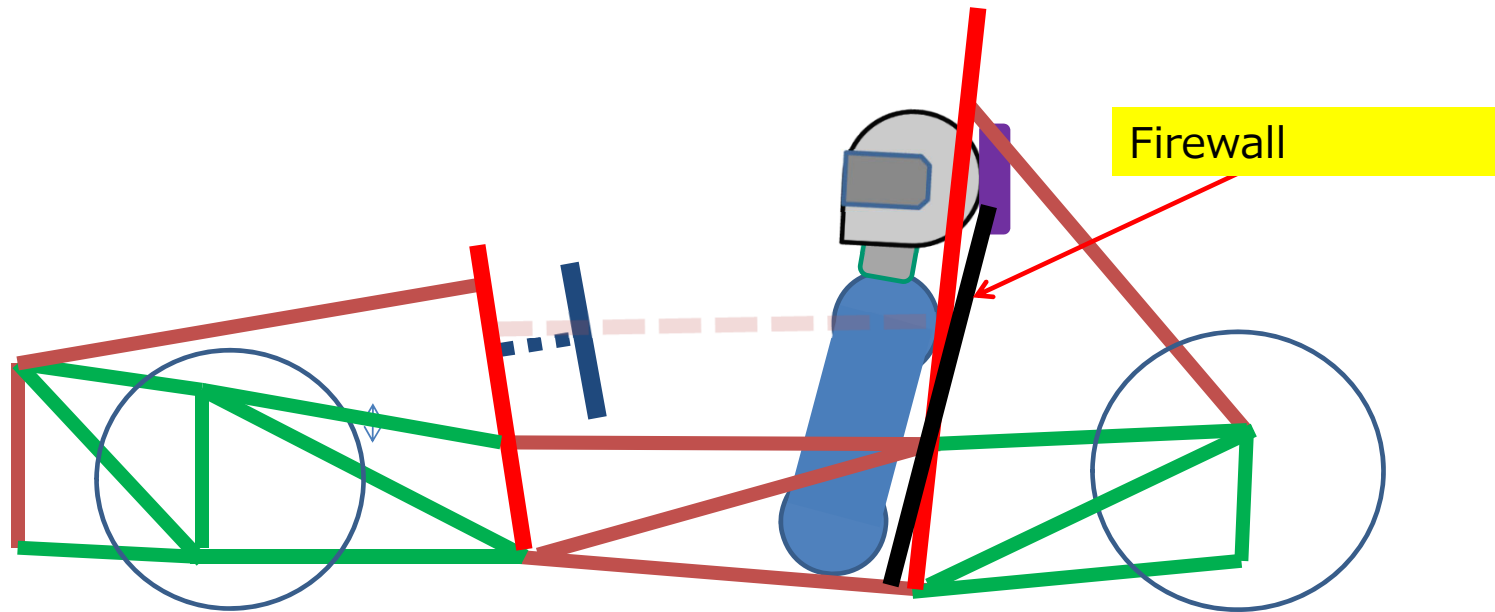
When the engine is disassembled and serviced
Ensure reassembly is done in the correct procedure

- Forgot to tighten bolts
- Double check to ensure that there is no shortage of tightening torque

At the 2016 Games, the connecting rod foot has been stuck.
It was fortunate that the \Rightarrow did not lead to a fire.



Driver Protection: 3 Firewall



Protect the driver from "any heat source". (T.1.8.1)

* Constructed with materials according to the temperature of the heat source.

Responding to high temperatures such as flames

Plate thickness: T0.7mm for aluminum, T0.5mm or more for iron plate is recommended.

* In the case of Fukai Manufacturing "enbrella",

•Multilayer product, single layer product (1mm): Confirmed compliance with fire resistance standards, can be used unconditionally.

•Single layer products (0.5mm, 0.3mm): Require fire resistance certification by the team

Firewalls must be made without gaps

Driver Protection: 3 Firewall

Production example (without gaps)



- Make a firewall without gaps. (The harness is threaded using a grommet)

Others: 4-(1) Shakedown



Carefully follow these steps:

- (1) Add fuel and check for leaks from the tank & fuel line!
- (2) Turn the engine stationary to prevent leakage of fuel, oil and water
Check again and again!
- (3) Gradually increase the speed and test run!
- (4) Acceleration, turning, stopping, suspension & brake confirmation! !!

※Shakedown proof must be submitted as soon as possible

at last



- Follow the main points and build a safe vehicle.
- Please complete the vehicle as soon as possible, check it carefully, and participate in the competition.
- Impossible participation in the tournament will induce an accident and cause trouble to the tournament itself and other teams.

In the 21st competition, we cleared the technical vehicle inspection in one shot,
Enjoy dynamic competitions.
Good luck with the team's consideration.

The following references

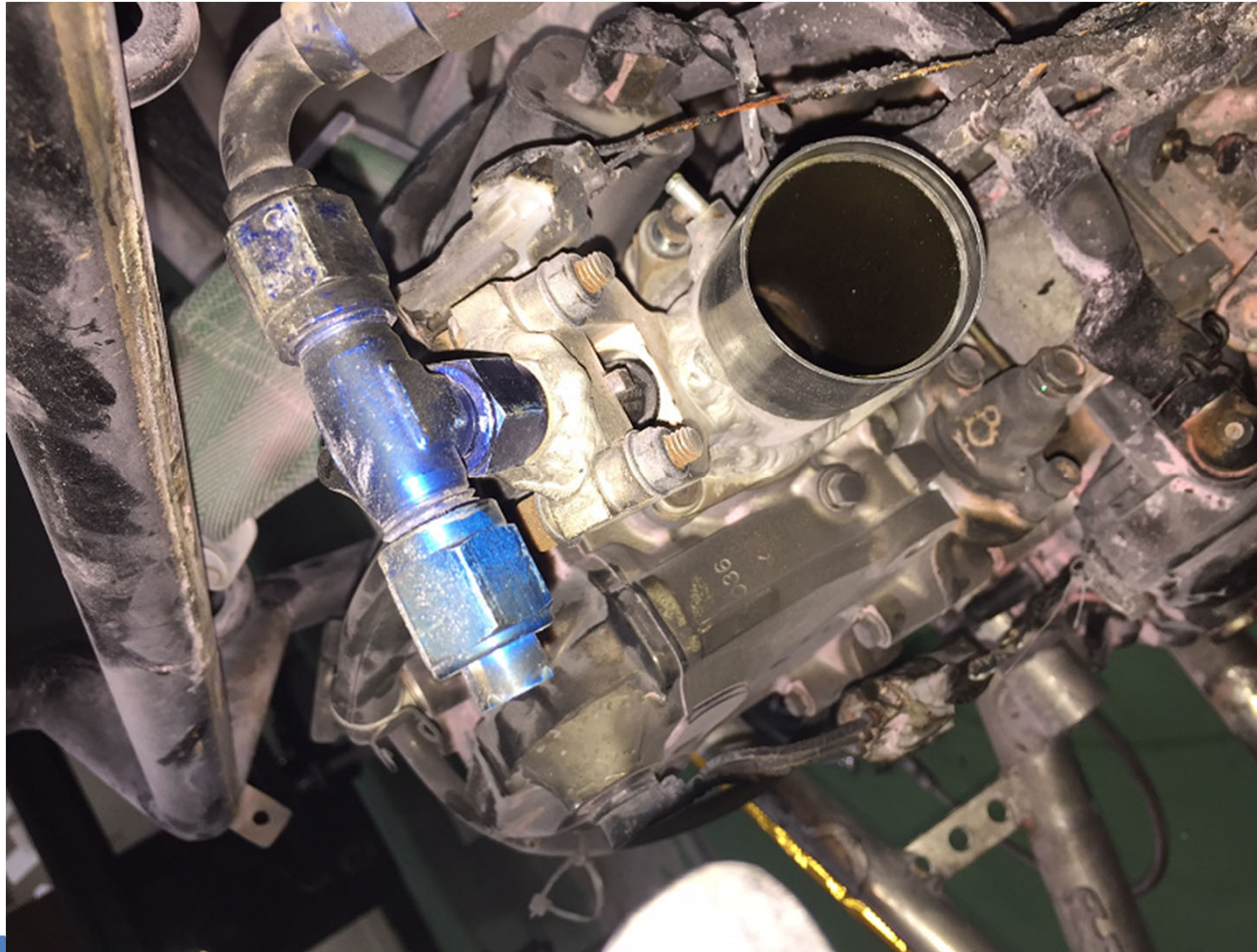
Fire case (team with top prize experience)



Fire caused by fuel leakage from the fuel line (joint).

The flames reached the driver, but the racing suit protected him and his skin turned a little red.

The direct cause is presumed to be poor tightening of the joint.



Prevent: 1-(3) Fuel tank (distance to exhaust pipe)

(Reference: JIS K2202-2012)

Octane number (research method)	Premium	:	96.0 or higher (No. 1)
	Regular	:	89.0 or higher (No. 2)
Density (15°C)		:	0.783g/cm ³ or less
Distillation properties	10% distillation temperature	:	70°C or less
	50% distillation temperature	:	75~110°C or less
	90% distillation temperature	:	180°C or less
	100% (end point)	:	220°C or less
	Remaining oil capacity	:	2.0°C or less
Flash point	Flash point	:	-20°C~-40°C
Ignition point	Ignition point	:	about 300 degrees C
Boiling point	Boiling point	:	30°C~200°C

Prevention: Driver thermal protection



Note: Drivers are protected by the following requirements: (Firewall)

T.1.6 Sufficient insulation must be used to prevent the driver from coming into contact with metals or other components that may have a surface temperature of 60 °C or higher when the driver is seated in a normal riding position.

The insulation may be outside the cockpit or coalesced into a driver seat or firewall.

The design allows for heat sources like exhaust pipes or coolant hoses/pipes and dry as in seats and floors

Evidence must be shown of dealing with three types of heat conduction with the panels with which the bars come into contact: thermal conductivity, convection and heat dissipation.

a. Heat transfer isolation by:

i.. No direct contact between the heat source and the panel

ii.. Heat-resistant heat transfer isolation material with a thickness of at least 8 mm (0.3 ins) between the heat source and the panel

b. Heat conduction isolation by providing a minimum air gap of 25 mm (1 inch) between the heat source and the panel

c. Heat dissipation isolation by:

i.. Metal heat shielding plate with a thickness of 0.4 mm (0.015 ins) or more

II.. Reflective metal plate or reflective tape incorporated in aii..